International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 8, Issue 6 Dec 2018, 71-74

TRANS STELLAR
•Journal Publications •Research Consultancy

A COMPREHENSIVE STUDY ON PHYSICAL PROPERTIES OF BLACK GRAM AND GREEN GRAM FOR DEVELOPING A PLANTER

M. MANOHARAN

Assistant Professor, Department of Farm Power and Machinery,

Mother Terasa College of Agriculture, Tamil Nadu, India

ABSTRACT

For optimizing the structural parameters for optimum performance of seeder or planter depends on seed size and its uniformity. Selected important physical and mechanical properties of black gram variety VBN-3 and green gram variety CO-6 were studied and its importance in inclined seed metering mechanism development discussed. The digital vernier caliper was used to measure the major axis and minor axis of black gram and green gram seeds. Standard procedures were employed for measuring bulk density and angle of repose. The major axis and minor axis of the selected varieties of black gram and green gram seeds were 3.97, 4.25, 3.60 and 3.92 mm, respectively, were considered in the design of cells on the metering plate of pulse planter. The average 1000 seed weight and bulk density of black gram and green gram varied between 51 to 56 g, 46 to 51 g, 1389.68 to 1494.43 kg m-3, 626.56 to 984.29 kg m-3 respectively. The mean angle of repose and coefficient of friction over the surfaces of plywood, galvanized steel, mild steel and rubber was 28.64°and 0.605, 35.55°and 0.746, 24.26° and 0.592 and 39.57° and 0.706 respectively, were recorded for black gram and 26.3°and 0.676, 32.6°and 0.823, 26.8° and 0.486 and 38.5°and 0.865 respectively were recorded for green gram.

KEYWORDS: Bulk Density, Seed Geometry, Co-Efficient of Friction, Black Gram & Green Gram Seeds

Received: Oct 01, 2018; **Accepted:** Oct 21, 2018; **Published:** Nov 13, 2018; **Paper Id.:** IJASRDEC201810

Original Article

1. INTRODUCTION

Pulses play a vital role in furthering sustainable agriculture as they are the major sources of dietary protein in the vegetarian diet. Besides being rich sources of protein, they maintain soil fertility through biological nitrogen fixation. Globally 60 million tones of pulses are produced annually from 70 million hectares and India is the largest producer with 33 per cent of global area and produce 25 per cent of the world's production. Even though India ranks first in terms of production of pulses still there is a challenge in mechanized sowing of green gram and black gram. The basic objective of sowing operation is to bear the seed, put the seed in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed (Oduma *et al*., 2014; Soyoye *et al*., 2016). However, in fabricating the form of this mechanized planting equipment, some properties of the seed which is to be planted must be determined in order to accurately specify the design considerations (Jouki and Khazaei, 2012). The physical properties of seed such as size, shape, axial dimensions, roundness and sphericity help to determine the maximum size of the cup in the seed plate, the weight help in the material selection for the frame of the planter, the bulk density and moisture content helps to know the interaction between the seed and the material used for the hopper of the planter at maximum heat level (Jayan and Kumar, 2004). To design the seed metering device for precision sowing of green gram and black gram, it is necessary to determine the physical properties of seeds as a function of seed size, shape, bulk density, angle of repose and co-efficient of friction of seeds.

Hence, an attempt was made to find the optimum design parameters of a planter by determining the relevant physical properties of black gram and green gram seeds predominant variety in Tamil Nadu.

2. MATERIALS AND METHOD

The predominant black gram variety Vamban-3 (VBN-3) and green gram variety Coimbatore-6 (CO-6) cultivated in regions of Tamil Nadu was selected for the study. The following physico-engineering properties of seed are important to determine the design factors of efficient farm equipment mainly planters.

- Seed geometry
- Bulk density
- Angle of repose
- Co-efficient of friction

2.1. Seed Geometry

The seed geometry pertaining to its major axis and minor axis of black gram and green gram seeds was measured with the help of a digital vernier caliper. The major and minor axis of randomly selected hundred seeds of black gram and green gram were measured. From the measured values, the maximum value of major and minor axis was selected for optimizing the cell size.

2.2. Bulk Density

The bulk density influences the design of volume of seed hopper and is affected by the moisture content and degree of packing. The bulk density of selected varieties of black gram (VBN 3) and green gram (CO 6) seeds was computed by measuring the volume of known weight of black gram and green gram seed samples. A seed sample of known weight was taken and filled in a graduated cylindrical jar. The volume occupied by the seeds was recorded. The procedure was repeated five times and the average value of the weight per unit volume was computed. Five samples of one thousand seed mass was determined for both black gram and green gram by measuring the weight of thousand seeds in an electronic balance having an accuracy of 0.001 g.

2.3. Angle of Repose

As the seeds flow due to gravity, the angle of repose influences the design of inclination of seed hopper. The angle of repose was measured using a rectangular box filled with black gram and green gram seeds. The filled box was kept horizontal. The seeds were then allowed to fall freely by gravity on a horizontal circular disc kept below the box. The seeds formed a heap on the disc. The procedure was repeated five times for the seeds of black gram and green gram. The angle of repose was determined for the materials, plywood, galvanized steel, mild steel and rubber. The radius of the base of the heap and the height of the heap were measured and angle of repose was calculated using the following expression.

Where,

$$\omega = \tan^{-1}\left(h/r\right)$$

ω = Angle of repose, degree

h = Height of heap, m

r = Radius of heap, m

This procedure was replicated five times for accuracy and the mean value was recorded for the selected varieties of black gram (VBN 3) and green gram (CO 6) separately.

2.4. Co-Efficient of Friction

The co-efficient of friction experiment was carried out using test surfaces of plywood, galvanized steel, mild steel and rubber with five replications. The experimental apparatus consist of a tube container filled with known quantity of selected seeds and the tube was connected by a string running over a frictionless pulley to a loading pan for the determination of the co-efficient of static friction. Weights were added to the pan until the tube began to slide. The weight of the black gram and green gram seeds and the added weights comprise the normal force N and friction force F, respectively. The coefficient of static friction, μ was calculated as the ratio

$$\mu = F/N$$

3. RESULTS AND DISCUSSIONS

The geometric mean diameter or maximum seed dimension is a useful tool in the design of the metering cells. When the seed metering disc rotates inside the seed hopper, each seed may position itself with respect to a major or minor axis. The configuration of the cell should accommodate the seed in any position without causing external injury. The metering cells for black gram planter based on the maximum seed dimension should be 4.25 mm while the metering cells for green gram planter should be 4.2 mm.

The average 1000 seed weight of black gram and green gram varied between 51 to 56 g, 46 to 51 g respectively. The calculated average 1000 seed weight helps in determining the seed rate. The measured bulk density for black gram and green gram ranged from 1389.68 to1494.43 kg m^{-3}, 626.56 to 984.29 kg m^{-3} respectively with the mean values determined to be 1444 and 669 kg m^{-3} respectively. The measured values of bulk density were used for calculating the volume of the seed hopper for holding and metering pulse seeds.

The angle of repose for black gram over four surfaces plywood, galvanized steel, mild steel and rubber was determined and it ranges from 24° to 35°, 29° to 48°, 20° to 41° and 34° to 52° respectively, with the mean angle repose over the four surfaces determined to be 28.64°, 35.55°, 24.26° and 39.57° respectively. Similarly, the angle of repose for green gram was also found. The surfaces employed were plywood, galvanized steel, mild steel and rubber. The angle of repose ranges from 21° to 32°, 28° to 43°, 24° to 38° and 33° to 50° respectively, with the mean angle of repose over plywood, galvanized steel, mild steel and rubber determined to be 26.3°, 32.6°, 26.8° and 38.5° respectively. The angle of repose helps in designing the hopper of the planter and to ensure free movement of seeds from the hopper towards the seed metering disc. The mean angle of repose for black gram is larger than that of green gram and this is due to the fact that the sphericity of black gram is larger than that of green gram.

The coefficient of friction for black gram over four surfaces of plywood, galvanized steel, mild steel and rubber were found to range from 0.464 to 9.045, 0.486 to 1.126, 0.356 to 0.834 and 0.588 to 1.244 respectively, with the mean coefficient over the four surfaces determined to be 0.605, 0.746, 0.592 and 0.706 respectively. Similarly, the coefficient of friction for green gram was determined. The surfaces used to be plywood, galvanized steel, mild steel and rubber.

The coefficient ranges from 0.440 to 1.145, 0.563 to 1.243, 0.377 to 0.948 and 0.624 to 1.850 respectively, with the mean coefficient of friction over these surfaces to be 0.676, 0.823, 0.486 and 0.865 respectively. The coefficient of friction helps in selecting the material for planter hopper and seed plate.

4. CONCLUSIONS

Based on the results drawn from the physical and mechanical properties of black gram and green gram, the following conclusions were made.

- The metering cells for black gram planter based on the maximum seed dimension should be 4.25 mm while the metering cells for green gram planter should be 4.2 mm.
- The sliding gate should be designed with an angle above 45° for both black gram and green gram seeds, so as to have free flow of seeds from the hopper to the metering unit.
- The hopper and seed metering disc should be made of mild steel since co-efficient of friction found to be minimized with the material of mild steel when compared to plywood, galvanized steel and rubber.

ACKNOWLEDGEMENT

The guidance provided by Dr. K. Kathirvel, Retired Dean, Agricultural Engineering College and Research Institute (AEC&RI), Kumulur, Trichy, is acknowledged for carrying out this study. The author is grateful to the Department of Agricultural Machinery Research Centre, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, for providing the facility to carry out the research.

REFERENCES

1. *Jayan, P. R., and V. J. F. Kumar. 2004. Planter design in relation to the physical properties of seeds. Journal of Tropical Agriculture, 42(1-2): 69–71.*
2. *Jouki, M., and N. Khazaei. 2012. Some physical properties of rice seed. Research Journal of Applied Sciences, Engineering and Technology, 4(13): 1846–1849.*
3. *Oduma, O., J. C. Ede, and J. E. Igwe. 2014. Development and performance evaluation of a manually operated cowpea precision planter. International Journal of Engineering and Technology, 4(12): 693–699.*
4. *Soyoye, B. O., O. C. Ademosun, and E. O. Olu-Ojo. 2016. Manually operated vertical seed-plate maize planter. CIGR Journal, 18(4): 70-8.*
5. *Hasan, B. K., & Ram, M. R. (2015). Evaluation of PGPR and organic manure applications on soil fertility, growth, nodulation and yield of black gram (Vigna mungo L. Hepper). International Journal of Agricultural Science and Research (IJASR), 5(2), 183-191.*